MINISTRY OF DEFENCE

LOCH EWE

REPORT of ASSESSMENT
of the
HAZARD IDENTIFICATION & RISK EVALUATION

7 FEBRUARY 2005

Radiation (Emergency Preparedness & Public Information) Regulations
Regulation 6 & Schedule 5

1. INTRODUCTION

The Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) 2001 require Hazard Identification and Risk Evaluation (HIRE) be undertaken for any premises containing more than the quantity of radioactive material specified in the Regulations. This document is the Report of Assessment of the HIRE for the nuclear submarines, defined as premises under the Regulations, at the Loch Ewe Z berth. The Report of Assessment, together with such supporting information as deemed necessary by the Health and Safety Executive (HSE), is provided to enable the HSE to assess the risk to the health or safety of persons who could be affected by the work with ionising radiation undertaken at Loch Ewe.

NOTE: Some sections of this report of assessment necessarily contain information in an abbreviated form and with limited technical detail. This has been done in the interest of national defence and public security and is in accordance with the agreement of the Health and Safety Executive (HSE) who have exercised their powers under regulation 16 (6) of REPPIR. The HSE have access to fuller, more detailed and classified information to enable them to satisfy themselves on the acceptability of this assessment.

2. LOCATION AND ENVIRONMENT

2.1	**Operator Name:**	Commander-in-Chief Fleet, Ministry of Defence
2.2	**Operator Address:**	Ministry of Defence: (Sponsor: Naval Base Commander, HMNB Clyde, Helensburgh, Dunbartonshire, G84 8HL)
2.3	**Address of Premises:**	Loch Ewe, Wester Ross, Scotland. O/S Grid Ref: a. NATO Pol Jetty: NG 8720 8765 b. A1 buoy: NG 8490 9040
2.4	**History:**	The Z Berth has been used since 1963

2.5 **General Description:**

2.5.1 The Loch Ewe Z Berth comprises a NATO Pol Jetty and a Buoy located on the north east coast of Loch Ewe in the north west coast of Scotland. The meteorological conditions are typical for the West of Scotland with a prevailing west to south westerly wind and above average UK rainfall.

2.5.2 The local authority responsible for the area surrounding the Loch Ewe berth is Highland Regional Council.

2.5.3 The total population distribution extending 2km from the MOD Z berths at Loch Ewe is detailed in Table 1.

LOCATION	POPULATION DATA
A1 Buoy	150
NATO Pol Jetty	350

Table 1 Population Data 2km from Submarine Berth

3. ACTIVITIES ON THE PREMISES

3.1 The Z berth provides the facility for nuclear submarines to visit this location for operational or recreational purposes.

3.1 The nuclear submarine visiting the Loch Ewe berth contains more than the quantity of radioactive material specified in Schedule 2 of the Regulations. A HIRE has been conducted for visiting nuclear submarines. A brief description of the premises (ie submarine) and the containment arrangements for the radioactive substances are described below.

Facility	Description	Containment
Submarine Reactor	Pressurised Water Reactor (PWR). Fission of Uranium, contained in fuel elements, takes place in the reactor core. The resulting fission products, including radioactive isotopes of iodine, caesium and krypton, are contained within the fuel cladding. The heat generated by the fission process is removed from the core by water contained in a sealed circuit. This water is pumped through steam generators where the heat is transferred to a separate, secondary circuit.	The fuel elements are contained within a high integrity cladding, designed to prevent the release of radioactive fission products. Should the cladding fail, the primary coolant system, a pressurised, sealed circuit, would contain the fission products. Beyond the primary coolant system, a third containment boundary exists which is designed and constructed to meet the rise in pressure that could result from a failure of the primary coolant system. The final containment boundary is the submarine pressure hull.
Nuclear weapons carried on submarines	Nuclear weapons may be carried in Vanguard class submarines. Plutonium, Uranium and Tritium are contained within the nuclear weapon system.	Radioactive substances are enclosed within robust multiple layered containers secured within launch tubes in a continually monitored and controlled environment.

Table 2 - Radioactive Substances with a Hazard Identification and Risk Evaluation

4. SAFETY ASSESSMENT PROCESS

4.1 Internal Regulation

A nuclear powered submarine visiting the MOD Z berth at Loch Ewe, as a Ministry of Defence facility, is not subject to licensing under the Nuclear Installations Act. For submarine reactor operations and nuclear weapon operations, the MOD operates an internal nuclear regulatory regime that mirrors the standards and procedures required by Nuclear Installations Inspectorate (NII) licensing approach.

4.2 Naval Pressurised Water Reactor (PWR)

The Design Authority for the Naval PWR, Rolls Royce, is charged with producing a Reactor Plant Safety Justification (RPSJ) covering all classes. This safety case is based on deterministic and probabilistic safety assessment of the PWR and its associated systems. The RPSJ is independently peer reviewed and then subjected to Independent Nuclear Safety Assessment (INSA) by Serco Assurance (formerly part of AEA Technology). They produce a Nuclear Safety Clearance Document for each submarine with a class review, which is formally reviewed by the Chairman of the Naval Nuclear Regulatory Panel (CNNRP). When satisfied, CNNRP issues a Safety Clearance Letter to MOD's Central Plant Control Authority who authorises the operation of each submarine.

4.3 Safety Controls and Engineering Design

The containment arrangements for a nuclear submarine are described in Table 2. In addition, there are engineered and procedural safeguards to prevent and mitigate any accident scenario. All equipment is designed and constructed to a high specification, and undergoes thorough examination, testing and regular planned maintenance. Operation of all equipment is conducted according to operating procedures, by suitably qualified and experienced staff.

4.4 Nuclear Weapons embarked in Submarines

The Design Authority for the nuclear weapon, AWE plc, undertakes trials and assessments to support the Hazard Identification and Risk Evaluation. All of this assessment work is separately reviewed. Approval of this work results in the issue of appropriate licences for nuclear weapon activities to be undertaken.

For nuclear weapons carried on submarines, Director Strategic Weapon Systems is the UK regulatory authority responsible for ensuring that all UK strategic weapons system equipment and procedures comply with UK safety legislation.

4.5 Safety Management, Staffing and Training

The safety responsibilities of all personnel are defined in Submarine Operating Documentation. All submarine personnel and those MOD personnel that support the visit of a nuclear submarine to Loch Ewe are suitably qualified and experienced for the work that they are expected to perform. A continuous process of audit and review is used to ensure that procedures remain current and effective. Minimum manning levels have been assessed and are documented in Submarine Operating Procedures. This ensures that there are adequate staff and resources available at all times to enable safe plant operation and provide a robust emergency response capability.

5. HAZARD IDENTIFICATION AND RISK EVALUATION

5.1 Introduction

The Radiation (Emergency Preparedness and Public Information) Regulations define the terms “radiation accident” and “radiation emergency”. A radiation accident requires immediate action to prevent or reduce the exposure to ionising radiation of employees or other persons; a radiation emergency is an event which is likely to result in a member of the public being exposed to ionising radiation, as defined in the Regulations. Hence a radiation accident may, but will not necessarily, result in a radiation emergency.

5.2 Submarine Reactor

A range of potential accident scenarios have been analysed, the majority of which would not result in a release of radioactivity by virtue of the engineering and procedural safeguards described previously. The analysis considered those factors which could lead to a loss of cooling capability, as well as those which could give rise to an unintended self-sustaining nuclear chain reaction or the loss of control of an intended self –sustaining chain reaction. For a significant release to occur it is necessary for there to be a plant failure followed by breach of the multiple containment barriers between the radioactive fission products contained within the fuel and the outside environment. These barriers include the high integrity fuel cladding, the primary coolant sealed circuit, the containment structure and the submarine hull.

The HIRE for the submarine reactor has identified a number of scenarios, which could lead to an off-site release of radioactive material. A radiation emergency, as defined within the Regulations, can result from a submarine reactor accident.

Accidental releases from the site could occur over periods of several hours, depending on the circumstances and the level of damage.

In order to develop an accident response strategy, the analysis has considered the probability of each accident sequence occurring and the consequences of the fission product release resulting from that sequence. A two stranded approach has then been used to determine an appropriate strategy: an analysis of the probability and magnitude of any radiation exposure given that a radiation accident has been declared; and an analysis of the optimum countermeasure strategy for protection of individuals from any potential radiation exposure. Both analyses have considered all of the identified accident sequences. The appropriateness of introducing countermeasures has been determined on the basis of published advice from the National Radiological Protection Board (NRPB). This approach has resulted in a recommended accident response strategy based on a range of accident scenarios and analyses.

6. IMPLICATIONS FOR RADIATION EMERGENCIES

6.1 Submarine Reactor

In the event of a radiation emergency, the likely exposures to those members of the public within the zone extending approximately 2 km from the location of the plant could exceed 5 mSv. It is very unlikely that exposures in excess of 5mSv could be received beyond this zone, however, a small number of low probability scenarios have been identified with more significant consequences. In addition, personnel on the premises and intervention workers could exceed the current statutory dose limits for radiation workers as a result of a radiation emergency.

In deriving the recommended countermeasures strategy, due account has been taken of all identified accident scenarios.

The recommended response strategy to a radiation emergency would be implemented in two stages. Immediate countermeasures are set out within the operator's emergency plan, affecting only those personnel within the 550m automatic countermeasure zone. Implementation of the recommended off-site response would affect individuals in the pre-planned countermeasure zone out to approximately 2km downwind from the Base. These individuals would be advised to shelter to reduce any potential radiation exposure and to take stable iodine tablets to minimise the radiation exposure received as a result of inhalation of any radioactive iodine released. Both the On-site and Off-site plans would be implemented as precautionary measures prior to the detection of any release of radioactivity.

The basis for food controls applied by the Food Standards Agency (FSA) will be against food intervention levels required by EC Regulations.

These arrangements were developed and agreed in consultation with Local Authorities, and are articulated within the Off-Site Emergency Plan for Loch Ewe Z Berth.

6.2 **Nuclear Weapons embarked in Submarines**

The assessment made by the MoD shows that a radiation emergency as a result of a nuclear weapon accident onboard a submarine is not reasonably foreseeable. There is therefore no formal requirement for an Operator's Emergency Plan or an Off-site Emergency Plan.

7. CONCLUSIONS

A Hazard Identification and Risk Evaluation have been conducted for nuclear powered submarines using the MOD Z Berths Loch Ewe as required by the Regulations. These assessments have indicated that only a submarine reactor accident could lead to a radiation emergency.

The probabilities and consequences of the full range of potential accidents have been analysed and a response strategy developed to address them. To cope with the unlikely event of a radiation emergency, the nuclear submarine's company have an Operator's Emergency Plan in place detailing the on-site response. The appropriateness of implementing countermeasures off-site has been assessed in the light of national legislation and guidance, and a precautionary strategy has been recommended to a distance of approximately 2km downwind from the site. The recommended pre-planned countermeasure zone is shown on the maps at Annex A. The planning for a submarine reactor accident is valid in outline for a nuclear weapon accident even though it is not reasonably foreseeable.

Emergency planning for the MOD Z berth at Loch Ewe is addressed as follows, this ensures a co-ordinated response strategy to be regularly reviewed, monitored and updated as required:

a. On-Site:
   - Naval Base Board.
   - Clyde Nuclear Safety Committee (CNSC).
   - Base Emergency Services Committee (BESC).
   - Nuclear Accident Response Organisation Sub Committee (NAROSC).
   - Appropriate sub committees and Working Groups of the CNSC, BESC, NAROSC.
   - MOD Nuclear Powered Warship Berthing Co-ordinating Committee

b. Off-Site:
   - Highland & Islands Emergencies Co-ordinating Group (HIECG).
   - Appropriate sub-committees and Working Groups of the HIECG.
   - MOD Nuclear Powered Warship Berthing Co-ordinating Committee.

MOD has established engineering and procedural safeguards to prevent a radiation accident from occurring, and to limit the consequences of any accident that could occur. The safety management systems to ensure effective control of radioactive substances are regularly reviewed and audited.